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Permian Bryozoans from Some Localities in the Khao Hin Kling Area Near Phetchabun, North-central Thailand

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Abstract Permian bryozoan samples from 5 localities in the Khao Hin Kling area add to previous faunal studies. About 30 species in 18 genera include the new species, *Fistulipora siamensis*, *Fistulipora sawatai* and *Rhombocladia nakornsri*. Sixteen previously described and other indeterminable species complete the listing. The species are Early Permian (Artinskian) to Late Permian (late Guadalupian to early Dzhulfian) and are typical of the Southern and Central Tethys realms.

Key Words Bryozoans, Permian, Tethys realm, Tak Fa Formation, Thailand

Introduction

In 1986 as part of the biostratigraphic study of the Paleozoic and Mesozoic in central and northern Thailand, our RESEARCH GROUP (leader: Professor Juichi YANAGIDA, Kyushu University) visited the Khao Hin Kling area at the west side of Highway 21, about 50 km south of Phetchabun, and recognized many different fossils in the Permian Tak Fa Formation of the Ratburi Group. A preliminary report was made by the RESEARCH GROUP (1988). This study describes the bryozoans.

Fossil Locality

Our RESEARCH GROUP (YANAGIDA ed., 1988) recognized 23 localities in the Khao Hin Kling area, all of which are in limestone outcrops in the Permian Tak Fa Formation of the Ratburi Group (NAKORNSRI, 1976, 1981; BUNOPAS, 1981), (Fig. 1). The fossils include; foraminifers, fusulines, bryozoans, brachiopods, sponges, corals, etc.

In a preliminary report by the RESEARCH GROUP (1988) many fossils were noted especially fusulines which are important for age determination. In this study, all fossil localities in the Khao Hin Kling area are shown by the alphabetical symbols (A ~ W) and the numbers in parentheses are those used in the RESEARCH GROUP.

Loc. A (860809-01) Foraminifers, bryozoans, brachiopods and gastropods.
Loc. B (860809-03) Schwagerinid fusulines (unnamed).
Loc. C (860809-04) Brachiopods.
Loc. D (860809-02) Gastropods and bivalves in silicified shale.

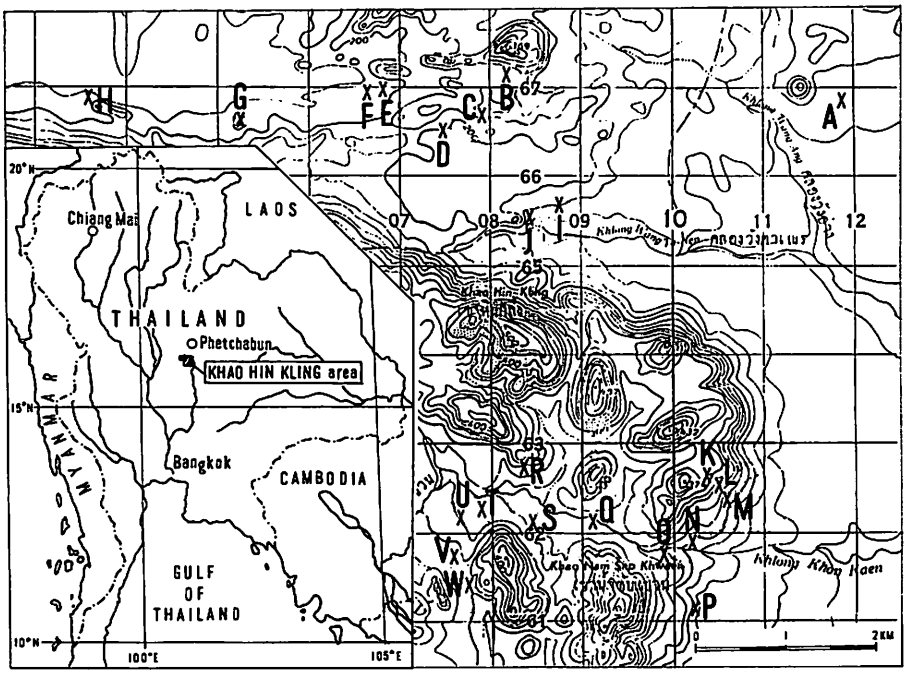

Fig. 1. Map showing the sample localities in the Khao Hin Kling area. (after RESEARCH GROUP, 1988)

Loc. E (860809-05) Fusulines (*Schwagerina* sp., *Rugosofusulina*? sp., *Quasifusulina longissima* (Moeller), *Sphaeroschwagerina princeps* (EHRENBERG)).

Loc. F (860809-06) Fusulines (*Schwagerina* sp., *Rugosofusulina*? sp., *Sphaeroschwagerina princeps* (EHRENBERG)). Earliest Permian (Asselian).

Loc. G (860809-07) Fusulines (*Mesoschubertella*? sp.).

Loc. H (790809-02) Brachiopods.

Loc. I (790809-01) Fossils not listed.

Loc. J (790807-03) Fossils not listed.

Loc. K (860810-04) Foraminifers, bryozoans and sponges.

Loc. L (860810-03) Foraminifers, fusulines (*Nankinella* sp.) and bryozoans.

Loc. M (860810-02) Foraminifers and fusulines (*Nankinella*? sp.).

Loc. N (860810-01) Foraminifers, fusulines (schwagerinids) and bryozoans. Early Permian (Artinskian).

Loc. O (860811-02 ~ 05) Bryozoans and brachiopods.

Loc. P (860811-01) Foraminifers and fusulines (*Nankinella* sp.) (highly recrystallized).

Loc. R (860813-01) Foraminifers, fusulines (*Schubertella* sp.), corals and brachiopods.

Loc. S (860811-07) Foraminifers.

Loc. T (860813-02) Fusulines (Schwagerinids, *Nankinella* sp.) and brachiopods.

Loc. U (860813-03) Fusulines (*Pseudofusulina*? sp.).

Loc. V (860813-04) Foraminifers.

Loc. W (860813-05) Foraminifers, fusulines (*Pseudofusulina* sp., *Misellina* sp.) and corals.

Many years ago (probably in the early 1960s), R. TORIYAMA collected some blocks of dark calcareous mudstone containing brachiopods and bryozoans from the east side of Khao Hin Kling near Phetchabun. The brachiopod fauna was described by YANAGIDA (1964) and the bryozoan fauna by SAKAGAMI (1975). Using brachiopods these faunas suggested an approximate correlation with the *Parafusulina* zone through the middle part of the *Yabeina-Lepidolina* zone, and appeared to be the interval between the Abadehian and Dzhulfian (s.s) by bryozoans. Unfortunately, the precise locality of the TORIYAMA's material is uncertain and it is not shown in Figure 1.

Bryozoan Faunas

The bryozoans were found at 5 localities: (see also Table l).

Loc. A. Bryozoans: *Pseudobatostomella multidiaphragma* and *Polypora soyanensis.*

The originally described specimen of *Pseudobatostomella multidiaphragma* is known from the east side of Khao Hin Kling. *Polypora soyanensis* was originally described from the lower Kazanian (Upper Permian) of the Russian Platform. Associated fossils are foraminifers, brachiopods and gastropods, but all of them are unnamed. From the two bryozoan species, the geological age is estimated to be Upper Permian.

Loc. K. Bryozoans: *Fistulipora timorensis, Eridopora parasitica, Sulcoretepora*? sp., *Pseudobatostomella* sp., *Paralioclema mongraiensis, Rhabdomeson* sp., *Clausotrypa* cf. *C. thaiensis, Rhombocladia nakornsri* n. sp., *Fenestella* sp. and *Polypora* sp.

Fistulipora timorensis and *Eridopora parasitica* (incl. *E. major*) are known widely from the Permian (Artinskian to Guadalupian) of the Tethyan region, and they occur also at Locs. N and O. *Paralioclema mongraiensis* was originally described from Khao Ta Mong Rai and *Clausotrypa thaiensis* from Ko Muk, both in Thailand. The Khao Ta Mong Rai bryozoan fauna was considered to be Artinskian but some of the described species seem to be a little older. The Ko Muk bryozoan fauna was thought to be most probably late Artinskian. *Rhombocladia nakornsri* is a new species, but the genus *Rhombocladia* is reported from only the lower Artinskian of the Southern Tethys region (Western Australia) and the Sakmarian of the Russian Platform. Associated fossils are foraminifers (*Pachyphloia* sp.) and sponges (*Amblysiphonella*? sp.). The geological age of this bryozoan fauna is estimated to be Artinskian to Guadalupian.

Loc. L. Bryozoans: *Araxopora araxensis.*

Araxopora araxensis was originally described from the Dzhulfian of

Table 1. Distribution of the bryozoan fossils in the Khao Hin Klin area.

Species	Localities				
	A	K	L	N	O
Fistulipora timorensis BASSLER		○		○	○
Fistulipora siamensis n. sp.					○
Fistulipora sawatai n. sp.					○
Eridopora parasitica (WAAGEN and WENTZEL)		○			○
Fistulocladia? sp. indet.					○
Hexagonella cf. *H. tortuosa* WAAGEN and WENTZEL				○	○
Liguloclema meridianus (ETHERIDGE)					○
Sulcoretepora? sp. indet.		○			
Rhombotrypella sp. indet.				○	
Pseudobatostomella multidiaphragma SAKAGAMI	○				
Pseudobatostomella sp. indet.		○			○
Araxopora araxensis (NIKIFOROVA)			○		
Paralioclema cf. *P. mongraiensis* (SAKAGAMI)		○			
Rhabdomeson consimile BASSLER				○	○
Rhabdomeson sp. indet.		○			
Clausotrypa conferta BASSLER					○
Clausotrypa cf. *C.? thaiensis* (SAKAGAMI)		○			
Rhombocladia nakornsri n. sp.		○		○	
"*Fenestella*" spp. indet.		○		○	○
Minilya rhomboidea (NIKIFOROVA)				○	
Pennniretepora spp. indet.				○	○
Septopora cf. *S. orientalis* BASSLER					○
Polypora soyanensis MOROZOVA	○				
Polypora cf. *P. elegantissima* STUCKENBERG					○
Polypora cf. *multiporifera* CROCKFORD					○
Polypora koninkiana WAAGEN and PICHL				○	
Polypora spp. indet.		○			○

Transcaucasia. The genus *Araxopora* is known from the Kungurian to Dzhulfian of Central Tethys region and the Kazanian (Guadalupian) of the Southern Tethys region. A fusuline species of *Nankinella* is associated with it. The geological age may be Late Permian, most probably Guadalupian to Dzhulfian.

Loc. N. Bryozoans: *Fistulipora timorensis, Hexagonella* cf. *H. tortuosa, Rhombotrypella* sp., *Rhabdomeson consimile, Rhombocladia nakornsri* n. sp., "*Fenestella*" sp., *Minilya rhomboidea, Pennniretepora* spp., and *Polypora koninkiana.*

Fistulipora timorensis occurs also from the Locs. K and O. *Hexagonella tortuosa* and *Polypora koninkiana* were originally described from the Middle Productus Limestone Guadalupian of Salt Range (Pakistan). *Hexagonella* cf. *H. tortuosa* is common at Locs. K and O. *Rhabdomeson consimile* is known from the Permian (precise horizon is unknown) of Timor Island, and from Inner Mongolia, Western Xinjang of China. *Minilya rhomboidea* was described origi-

nally from the Lower Permian (*Pseudofusulina anderssoni* zone) at Kazarmennyi Kamen and later from the *Parafusulina* zone of the Iwaizaki Limestone, Japan.

This fauna resembles that of Loc. K, and the geological age may be Artinskian to Guadalupian.

Loc. O. Bryozoans: *Fistulipora timorensis*, *Fistulipora siamensis* n. sp., *Fistulipora sawatai* n. sp., *Eridopora parasitica*, *Fistulocladia*? sp., *Hexagonella* cf. *H. tortuosa*, *Liguloclema meridianus*, *Sulcoretepora*? sp., *Pseudobatostomella* sp., *Rhabdomeson consimile*, *Clausotrypa conferta*, "*Fenestella*" spp., *Penniretepora* spp., *Septopora* cf. *S. orientalis*, *Polypora* cf. *P. elengatissima*, *Polypora* cf. *P. multiporifera* and *Polypora* sp.

Fistulipora timorensis occurs also at Locs. K and N. *Eridopora parasitica* and *Hexagonella* cf. *H. tortuosa* are common at Locs. K and N, respectively, and *Sulcoretepora*? sp. is also common at Loc. K. *Liguloclema meridianus* was described from the Noonkanbah Formation (Artinskian) of Western Australia and from Khao Raen of Thailand, the age of which has been considered to be late Artinskian. *Clausotrypa conferta* was originally described from the Permian of Timor Island. *Septopora* cf. *S. orientalis*, *Polypora* cf. *P. multiporifera* and *Polypora* cf. *P. elegantissima* are close to the original specimens from Timor Island and Western Australia. Thus this fauna may be Guadalupian in age.

Putting together, the present bryozoan faunas indicate the typical Southern and Central Tethys realms, and may cover the later part of the Early Permian (Artinskian) to early part of the Late Permian (late Guadalupian to early Dzhulfian).

Systematic Description

All specimens treated in this study are deposited and registered in the Collections of the Kitakyushu Museum and Institute of Natural History, Kitakyushu City.

Order Cystoporida ASTROVA, 1964
Suborder Fistuliporina ASTROVA, 1964
Family Fistuliporidae ULRICH, 1882
Genus ***Fistulipora*** M'COY, 1850

Fistulipora timorensis BASSLER, 1929

Pl. 18, figs. 1–3

Fistulipora timorensis BASSLER, 1929, p. 44, pl. 3, figs. 4–9; SAKAGAMI, 1968b, p. 50, 51, pl. 6, figs. 1–3; MOROZOVA, 1970, p. 63, 64, pl. 2, fig. 1.

Fistulipora cf. *timorensis* BASSLER, SAKAGAMI, 1961, p. 16, figs. 1–8; RESEARCH GROUP, 1988, pl. 12, figs. 1–3; SAKAGAMI, 1995, p. 242, figs. 9–3, 4.

Material and Locality: KMNH IvP 600,018a, 600,019a, 600,020a, b, 600,023a,

600,024a, 600,025a, 600,026a, 600,028a, 600,029a, 600,030a (Loc. K); 600,050a, 600,051a, 600,054a (Loc. N); 600,088a, 600,096a (Loc. O).

Description: Zoarium attached to foreign objects such as bryozoans (*Paralioclema mongraiensis, Rhombocladia nakornsri*) or calcareous algae (*Amblysiphonella?*) is a thin layer, varying from 1.1 to 1.6 mm in thickness.

In tangential section, zooecial tubes broadly ovate or subcircular, gradually widening from the inner to outer region, longitudinal diameter excluding lunarium ranges from 0.26 to 0.38 mm and transverse diameter from 0.19 to 0.38 mm. Usually 4.5 to 5.5 zooecia per 2mm diagonally. Lunarium well developed, horse-shoe shaped, occupies about one third to nearly one half of zooecial circumference, its thickness from 0.026 to 0.052 mm. Vesicular tissue fine and regular in size, one to three vesicles between adjacent zooecia. Usually 9 to 10 vesicles per 1 mm horizontally.

In longitudinal section, zooecial tubes parallel coenelasma for a short distance and curve gradually upward, making a right angle to zoarial surface. Diaphragms usually lacking but occasionally present; one in a tube. Interzooecial tissue consists of regularly arranged vesicles which are usually depressed quadrate. 12 to 14 vesicles per 1mm longitudinally.

Remarks: The present form in essential characters and measurements is similar to *Fistulipora timorensis* which was described by SAKAGAMI (1968b) from the limestone of Khao Ta Mong Rai, peninsular Thailand. This species is characterized by the thin, encrusting zoarium and no diaphragm in the zooecial tube. The Chinese specimens described as *Fistulipora timorensis* by YANG, LU and XIA (1981), YANG and LU (1983) and XIA (1991) may belong to *Fistulipora siamensis* n. sp. described below.

Fistulipora siamensis n. sp.

Pl. 18, figs. 4–6

Fistulipora lunatifera BASSLER, RESEARCH GROUP, 1988, pl. 14, figs. 2, 5, 6.
Fistulipora timorensis BASSLER, YANG, LU and XIA, 1981, p. 86, pl. 4, fig. 2, pl. 5, fig. 4; YANG and LU, 1983, p. 265, pl. 1, figs. 7, 8; XIA, 1991, p. 188, 189, pl. 7, figs. 6, 7.

Material and Locality: KMNH IvP 600,095a, 600,097a, 600,098a (holotype), 600,099a, 600,100a, 600,101a, 600,102a, 600,103a, 600,104a (Loc. O).

Description: Encrusting zoarium growing upon foreign objects such as a brachiopod shell or bryozoan colony of *Polypora*. Thickest part of zoarium is about 2.5 mm.

In tangential section, zooecial tubes broadly ovate or subcircular, gradually widening from the inner to outer zone; longitudinal diameter excluding lunarium ranges from 0.26 to 0.45 mm and transverse diameter from 0.26 to 0.39 mm. Usually 3.5 to 4 zooecia per 2 mm diagonally. Well developed lunarium occupies about one-fourth to nearly one-half of zooecial circumference, its thickness from 0.05 to 0.06 mm. Vesicular tissue fine and regular in size, two to four vesicles between

adjacent zooecia. Usually 8 to 9 vesicles per 1 mm horizontally.

In longitudinal section, zooecial tubes parallel to coenelasma for a short distance and curve gradually upward, making a right angle to zoarial surface. Many thin and straight or slightly concave diaphragms in zooecial tubes, irregularly spaced at intervals of usually 0.13 to 0.39 mm. Interzooecial tissue consists of regularly arranged vesicles which are usually depressed quadrate. 14 to 16 vesicles per 1 mm longitudinally.

Remarks: This form was considered previously to be *Fistulipora lunatifera* by SAKAGAMI (in RESEARCH GROUP, 1988). *Fistulipora siamensis* resembles *Fistulipora timorensis* in the thin encrusting zoarium, but it can be distinguished from the latter species by the presence of many diaphragms in zooecial tube in *F. siamensis*. The specimens described as *Fistulipora timorensis* by YANG, LU and XIA (1981), YANG and LU (1983) and XIA (1991) may be included in this new species because those Chinese specimens can be distinguished from *F. timorensis* in having many distinct diaphragms. The microscopic measurements are also different from *F. timorensis*.

Fistulipora sawatai n. sp.

Pl. 19, figs. 1–3

Fistulipora sp. indet., RESEARCH GROUP, 1988, pl. 15, figs. 3, 5.

Material and Locality: KMNH IvP 600,090a, 600,091a (holotype), 600,092a, 600,094a (Loc. O).

Description: Oblique longitudinal and tangential sections attached to a zoarium of *Polypora* and some other bryozoans. Zoarium encrusting, consisting of layer about 1.8 mm thick.

In tangential section, zooecial tubes variable in diameter, ranging from 0.26 to 0.38 mm, usually 4 to 5 per 2 mm diagonally. Peculiar lunarium, thick and extending about a half of the zooecial circumference; thickness usually more than 0.10 mm. In some cases, the ends of lunarium strongly project into zooecial cavity. Vesicular tissue fine and regular in size, one to three vesicles between adjacent zooecia. Usually 7 to 8 vesicles per 1 mm horizontally.

In longitudinal section, zooecial tubes grow from coenelasma, curve gradually upward and form an angle of about 90° with outer surface of zoarium. Two diaphragms present, one is straight, located at middle part of tube and another is convex near surface. Interzooecial tissue consists of regularly arranged vesicles which are depressed quadrate.

Remarks: The present taxon is characterized by the peculiar lunarium with both sides strongly projecting into zooecial cavity. It can be distinguished easily from the previously described fistuliporid species. The specific name is dedicated to the late Dr. Hideho SAWATA (1917 ~ 1997) who for many years was committed to doing his

best for the development of geological science in Thailand.

Genus *Eridopora* ULRICH, 1882

Eridopora parasitica (WAAGEN and WENTZEL), 1886

Pl. 19, figs. 4–6

Fistulipora parasitica WAAGEN and WENTZEL, 1886, p. 923, pl. 45, fig. 6; pl. 105, figs. 1–4.
Eridopora parasitica (WAAGEN and WENTZEL), XIA, 1986, p. 232, pl. 132, figs. 8, 9, pl. 15, figs. 5, 7; SAKAGAMI and PILLEVUIT, 1997, p. 206, fig. 2–3.
Eridopora cf. *parasitica* (WAAGEN and WENTZEL), SAKAGAMI, 1980, p. 273, pl. 31, figs. 7–9.
Eridopora major BASSLER, 1929, p. 52, pl. 225(1), figs. 1–4; GORJUNOVA, 1975, p. 45, 46, pl. 3, fig. 1; RESEARCH GROUP, 1988, pl. 12, fig. 4, pl. 13, fig. 2, pl. 14, fig. 1; XIA, 1991, p. 189, pl. 7, figs. 8, 9.
Eridopora? sp. indet., RESEARCH GROUP, 1988, p. 15, figs. 1, 2.

Material and Locality: KMNH IvP 600,018b, 600,021a, b, 600,022a, 600,027a (Loc. K); 600,065a, 600,068a, 600,070a, 600,072a, 600,078a (Loc. O).

Description: Encrusting zoarium growing upon foreign objects such as bryozoan colony: *Rhombocladia nakornsri* n. sp. or brachiopod shell. The thickness of zoarium ranges from 1.8 to 2.1 mm.

In tangential section, zooecial tubes rounded triangular with moderately developed crescentic lunarium. Longitudinal diameter excluding lunarium ranges from 0.32 to 0.39 mm and transverse diameter from 0.26 to 0.39 mm. Usually 4 to 4.5 zooecia per 2 mm diagonally. Lunarium occupies about one-third to one-half of zooecial circumference, its thickness is variable, very thin in inner part and becoming thick in outer part and occasionally reaching more than 0.13 mm in thickest part. On the opposite side of lunarium projecting into a tube, a pair of small projections occasionally visible. Vesicular tissue well developed, not so regular in size and arrangement. Usually one to three vesicles between adjacent zooecia, and 7 to 9 vesicles per mm diagonally.

In longitudinal section, zooecial tubes run for a short distance along coenelasma, then curve rapidly upward, grow straight and making nearly right angle to zooecial surface. Thin and straight or slightly concave diaphragms closely distributed throughout tube, irregularly spaced at intervals between diaphragms varying from 0.04 to 0.26 mm. Interzooecial tissue consists of poorly arranged vesicular tissue, depressed quadrate in form. About 9 to 11 vesicles per mm longitudinally.

Remarks: As already mentioned by SAKAGAMI (1980, 1997), *Eridopora major* may be a junior synonym of *E. parasitica*. Among the specimens of this species widely distributed in the Tethyan realm, the present form is similar in all essential characters and measurements to *E.* cf. *parasitica* by SAKAGAMI (1980) from the lower part of Abadehian of the Abadeh region, Central Iran.

Family Cheilotrypidae MOORE and DUDLEY, 1944
Genus *Fistulocladia* BASSLER, 1929

Fistulocladia? sp. indet.
Pl. 20, figs. 5, 6

Fistulocladia sp. nov., RESEARCH GROUP, 1988, pl. 15, fig. 4, pl. 16, fig. 1.

Material and Locality: KMNH IvP 600,082a, 600,085a (Loc. O).
Description: Two transverse sections were examined. Zoarium consisting of cylindrical stem, having diameters 3.8 and 4.3 mm in two specimens, of which the endozone is about 2.0 mm.

Zooecial tubes in endozone subcircular, longitudinal diameter excluding lunarium ranges from 0.18 to 0.24 mm and transverse diameter from 0.17 to 0.26 mm. Zooecial tube in exozone ranges from 0.26 to 0.32 mm in diameter. Lunarium in endozone relatively thin, horse-shoe shaped, occupying about one-third to one-fourth of zooecial circumference; in exozone well developed and very thick. Usually one thicker, slightly convex diaphragm near aperture of zooecial tube and a thinner, slightly concave diaphragm occasionally observed at middle level of exozone. Vesicular tissue developed in endozone and inner part of exozone; dense fibrous stereom in exozone.
Remarks: UTGAARD (1983) revised the genus *Fistulocladia* BASSLER (1929) using a topotype of the type species, *F. typicalis*. There is some doubt as to its generic assignment because these is only transverse sections at hand, this taxon is tentatively placed in *Fistulocladia*. The present form can be distinguished from *F. typicalis* and it may be a new species, however, the specific determination must be postponed until more specimens are available.

Suborder Hexagonellina MOROZOVA, 1970
Family Hexagonellidae CROCKFORD, 1947
Genus *Hexagonella* WAAGEN and WENTZEL, 1886

Hexagonella cf. *H. tortuosa* WAAGEN and WENTZEL, 1886
Pl. 20, figs. 1–4

Compared:
Hexagonella tortuosa WAAGEN and WENTZEL, 1886, p. 914, 915, pl. 108, figs. 1, 3–5.
Hexagonella laevigata WAAGEN and WENTZEL., RESEARCH GROUP, 1988, pl. 16, figs. 4, 5.
Hexagonella sp. indet., RESEARCH GROUP, 1988, pl. 16, fig. 3.

Material and Locality: KMNH IvP 600,050b, 600,051b, 600,054b, 600,055a, 600,056a, 600,057a (Loc. N); 600,076a, 600,077b, 600,096b, 600,103b (Loc. O).

Description: Zoarium probably broad, parallel-sided, flattened, bifurcating frond. Exact thickness of zoarium is unknown but may be less than 2 mm.

In tangential section, zooecial tubes nearly circular, diameter ranging from 0.21 to 0.26 mm, usually 4.5 to 5 zooecia per 2 mm diagonally. Lunarium absent. Interzooecial tissue relatively fine and regularly arranged, usually 7 to 9 vesicles per mm horizontally. Hexagonellid ridges are observed in thin section cut close to the surface but their form is indistinct.

In longitudinal section, zooecial tubes proximally parallel to mesotheca for a short distance, curving rapidly upward and then extending directly to outer surface of zoarium at a right angle. Usually one diaphragm in outer zone of tube. Interzooecial tissue consists of quadrate vesicles arranged regularly in longitudinal series in inner zone; usually covered by thin, dark fibrous material in exozone.

Remarks: This form may be identical with *Hexagonella tortuosa* in all essential characters although the zoarial thickness seems to be thinner than that of the originally described specimens from the Middle Productus Limestone in the Salt Range by WAAGEN and WENTZEL (1886). It is similar to *Hexagonella kobayashii* which was described by SAKAGAMI (1968a) from Khao Phrik of Thailand in zoarial form and general appearance, but it differs from the latter species in having a horseshoe-shaped lunarium in zooecial tube.

Family Etherellidae CROCKFORD, 1957
Genus *Liguloclema* CROCKFORD, 1957

Liguloclema meridianus (ETHERIDGE), 1926

Pl. 21, figs. 1–3

Sulcoretepora(?) *meridianus* ETHERIDGE, 1926, in BRETNALL, p. 19, pl. 1, fig. 9; HOSKING, 1931, p. 15.
"*Sulcoretepora*" *meridianus* (ETHERIDGE), CROCKFORD, 1944b, p. 156, pl. 4, fig. 6, text figs. 29, 30.
Liguloclema meridianus (ETHERIDGE), CROCKFORD, 1957, p. 37 (not illustrated); RESEARCH GROUP, 1988, pl. 17, figs. 2, 3; ENGEL and ROSS, 1993, p. 17 (on microfiche), pl. 13, figs. 1–3.
Liguloclema cf. *meridianus* (ETHERIDGE), SAKAGAMI, 1973, p. 77, 78, pl. 11, figs. 1–4.

Material and Locality: KMNH IvP 600,083a (Loc. O).

Description: This single zoarium consists of a straight branch bifurcating laterally at nearly a right angle. Width of zoarium is about 2 mm and thickness is unknown.

In tangential section, zooecial tubes typically circular in tangential section, thick-walled, diameter ranging from 0.17 to 0.20 mm. The recumbent part of zooecia appears hook-shaped in thin section cut parallel to surface. Zooecial tubes near surface are regularly arranged and divided by thicker lines in longitudinal series, more than 6 rows of zooecia on one side of zooecium, 3 to 3.5 in 2 mm of longitudinal direction, about 5 to 6 in 2 mm in diagonal direction. In tangential section, interspaces between zooecial tubes near surface range from 0.26 to 0.38 mm in longi-

tudinal direction and 0.10 to 0.20 mm in diagonal direction.

In longitudinal section, zooecial tubes bifoliate and extend from mesotheca, proximally parallel to mesotheca for a short distance in endozone, and making sharp wide angle in exozone. Vesicular tissue well developed and irregularly arranged. Dense fibrous stereom covering the outermost part of zoarium, usually about 0.15 mm in thickness.

Remarks: The present form is identical in all essential characters and measurements with *Liguloclema* cf. *meridianus* which was described from Khao Raen in central Thailand, the geological age of which is thought to be most probably the late Artinskian. The present species was originally described as *Sulcoretepora*(?) *meridianus* by ETHERIDGE (in BRETNALL, 1926) from Western Australia and later CROCKFORD (1944b) described it in more detail as "*Sulcoretepora*" *meridianus*. Later CROCKFORD (1957) established the genus *Liguloclema* for two species, *typicalis* and *meridianus*, that have quite different internal structure in zooecial tubes. However, because the illustrations by these authors are very poor, detailed comparison and identification are difficult. UTGAARD (1983) noted that the internal taxonomy of this genus is poorly known.

Genus *Sulcoretepora* D'ORBIGNY, 1849

Sulcoretepora? sp.

Pl. 21, fig. 4

Sulcoretepora? sp. indet., RESEARCH GROUP, 1988, pl. 17, fig. 4.

Material and Locality: KMNH IvP 600,023b, 600,024b, 600,025b (Loc. K).

Remarks: A few transverse sections of small zoaria may belong to *Sulcoretepora*, however, they are too poor to make detailed comparison and specific identification.

Order Trepostomida ULRICH, 1882
Family Stenoporidae WAAGEN and WENTZEL, 1886
Genus *Rhombotrypella* NIKIFOROVA, 1933

Rhombotrypella sp. indet.

Pl. 21, fig. 6

Rhombotrypella sp. indet., RESEARCH GROUP, 1988, pl. 19, fig. 7.

Material and Locality: KMNH IvP 600,051c, 600,052a (Loc. N).

Description: Two longitudinal and partly tangential sections of cylindrical stems; 2.2 and 2.8 mm zoarial diameter. Diameter of endozones 1.3 and 1.6 mm, and width of exozones narrow, 0.48 and 0.64 mm, respectively.

In longitudinal section, zooecial tubes straight, parallel to longitudinal direction in inner part of endozone and then rapidly curving outward at right angles at base of exozone. Zooecial walls in endozone thin, commonly obliterated by diagenesis in many cases, accordingly the detailed texture is obscure. Zooecial walls become rapidly thickened, composed of finely laminated fibrous tissue in exozone. Monilae and diaphragms not observed.

In tangential section, zooecial tubes oval, regularly arranged in longitudinal and diagonal directions, usually 4 zooecia per 2 mm longitudinally and 6 per 2 mm diagonally. Longer and shorter diameters of zooecia range from 0.18 to 0.26 mm and 0.09 to 0.12 mm, respectively. Mesozooecia may be absent. Acanthostyles located at intersections of zooecial walls, composed of concentric fibrous calcite, their outside diameter ranges from 0.06 to 0.07 mm, and their inner diameter very small, probably less than 0.001 mm. Paurostyles in a single series between acanthostyles, their outside diameter about 0.03 mm.

Remarks: The present form is nearly the same size in zoarial diameter as *Rhombotrypella typica* which was described from the Lower Permian of the Andean region, South America, by BASSLER (1936) and SAKAGAMI (1995). However, it can be distinguished from *R. typica* by the lack of monilae and diaphragms, the larger diameter of zooecial tubes and fewer zooecia in 2 mm in longitudinal and diagonal directions. The number of zooecia is 4 and 6 in the present form, but 5 to 6 and 7 in *R. typica*.

With only two poorly preserved specimens available, detailed comparisons are difficult and specific identification is not possible.

Family Dyscritellidae DUNAEVA and MOROZOVA, 1967
Genus *Pseudobatostomella* MOROZOVA, 1960

Pseudobatostomella multidiaphragma SAKAGAMI, 1975

Pl. 21, fig. 7; Pl. 22, fig. 1

Pseudobatostomella multidiaphragma SAKAGAMI, 1975, p. 36, 37, pl. 4, figs. 1–4.
Pseudobatostomella sp. indet., RESEARCH GROUP, 1988, pl. 18, figs. 1, 2.
Araxopora? sp. indet., RESEARCH GROUP, 1988, pl. 18, fig. 3.

Material and Locality: KMNH IvP 600,002a, 600,003a, 600,007a, 600,008a, 600,009a, 600,012a, 600,015a, 600,016a, 600,017a (Loc. A).

Description: Zoarium consists of nearly straight, slender, cylindrical stem, diameter ranging from 1.3 to 2.2 mm. Bifurcation of stem observed in longitudinal section; angle of bifurcation about 60°.

In longitudinal section, zooecial tubes trend parallel to longitudinal direction of zoarium in endozone, but curve gradually outward, rather rapidly bending at the inner edges of exozone and going straight throughout exozone to reach the surface

at an angle of about 90°. Zooecial wall thin, slightly undulated in endozone, and gradually thickened toward exozone. Zooecial wall in exozone consists of finely laminated fibers. Diaphragms very fine, nearly straight to slightly concave, disposed usually one to two in endozonal tube, but three or more in some parts near surface of exozone.

In tangential section, zooecial tubes polygonal, thin walled in endozone, oval or polygonal with rounded corners and thickened toward exozone. Zooecial diameter ranging from 0.11 to 0.15 mm in shorter direction, 0.13 to 0.19 mm in longer direction. Zooecial apertures irregularly arranged. Mesozooecia common but not so many, irregularly arranged, usually oval or rounded polygonal in shape, ranging from 0.04 to 0.10 mm in diameter. Acanthostyles usually located at junction of zooecial walls, surrounded by concentric dark dense fibers. Outside and inner diameters 0.03 to 0.05 mm and 0.006 to 0.016 mm, respectively.

Remarks: This form is identical in all essential characters and measurements with the originally described *Pseudobatostomella multidiaphragma* by SAKAGAMI (1975), which was collected by R. TORIYAMA from the east side of Khao Hin Kling.

Pseudobatostomella sp. indet.

Pl. 21, fig. 5

Dyscritella? sp. indet., RESEARCH GROUP, 1988, pl. 19, fig. 1.

Material and Locality: KMNH IvP 600,023a (Loc. K).

Remarks: A single oblique section shows a slender zoarium with cylindrical ramose branches, diameter about 1.3 mm. This form is similar to *Dyscritella tenuirama* in the general appearance, but the presence of a diaphragm in the zooecial tube warrants its inclusion presence *Pseudobatostomella.*

Family Araxoporidae MOROZOVA, 1970
Genus ***Araxopora*** MOROZOVA, 1965

Araxopora araxensis (NIKIFOROVA), 1933

Pl. 22, fig. 5

Batostomella spinigera var. *araxensis* NIKIFOROVA, 1933, p. 13, 14; 36, pl. 4, figs. 1–4.
Stenodiscus granularis YANG, 1958, p. 124, 125, 133, 134, pl. 2, figs. 2–8.
Araxopora araxensis (NIKIFOROVA), MOROZOVA in RUZHENTSEV and SARYCHEVA, 1965, p. 186, 187, pl. 25, figs. 4, 5, pl. 26, fig. 5, text-fig. 20; SAKAGAMI, 1976, p. 402, 403, pl. 42, figs. 8–11; ASTROVA, 1978, pl. 45, fig. 3; pl. 46, fig. 2, text-fig. 30; YANG and LU, 1979, p. 352, pl. 1, fig. 1; LU, 1982, p. 181, pl. 71, fig. 2; XIA, 1985, p. 380, pl. 1, figs. 1–6; LU, 1986, p. 119, pl. 5, figs. 1, 2; HUANG and LU, 1986, p. 364, 365, pl. 2, figs. 5–7; RESEARCH GROUP, 1988, pl. 19, fig. 3.

Material and Locality: KMNH IvP 600,031a, 600,032a, 600,033a (Loc. L).

Descriptive remarks: Zoarium is a cylindrical stem, 4.5 mm in diamter. Diameter of endozone about 3.1 mm and thickness of exozone about 0.8 mm. Owing to the very thin inner wall, the endozone is crushed. Exozonal wall thickens rapidly and consists of dark, coarse, laminated fibrous material. One to two diaphragms may be in a exozonal tube but they are crushed in many cases. Zooecial diameter along horizontal direction is 0.10 to 0.13 mm.

In spite of only transverse sections, the specimens can be easily identified based on characters and measurements as *Araxopora araxensis*. *Araxopora araxensis* described originally from Armenian Dzhulfa of Transcaucasia has been widely known from the Guadalupian to Dzhulfian of Central Tethys region. XIA (1985) included *A. malayensis* SAKAGAMI (1973) and *A. fistulata* LI (1977) in *A. araxensis*.

Genus *Paralioclema* MOROZOVA, 1961

Paralioclema cf. *P. mongraiensis* (SAKAGAMI), 1968

Pl. 22, fig. 2, 3

Compared:
Leioclema mongraiensis SAKAGAMI, 1968, p. 55, 56. pl. 9, figs. 1–3; RESEARCH GROUP, 1988, pl. 13, fig. 1.

Material and Locality: KMNH IvP 600,020c, 600,022b (Loc. K).
Description: Encrusting zoarium encrusting on *Rhombocladia nakornsri* and covered by *Fistulipora timorensis*. Thickness of zoarium about 1 mm.

In longitudinal section, zooecial tubes straight and arise nearly at a right angle from coenelasma. Zooecial wall thin in very narrow endozone but gradually thickened in exozone. Diaphragms in zooecial tubes are thin, complete, slightly concave, spaced at intervals as wide as or less than zooecial diameter, and more densely spaced near aperture.

In tangential section, zooecia circular with irregular margin; diameter ranges from 0.17 to 0.21 mm. Mesopores circular; diameter ranges from 0.06 to 0.12 mm. Acanthostyles surrounded by concentric laminate walls, usually located at the junction of zooecial walls. Outer and inner diameters about 0.06 mm and less than 0.01 mm, respectively.
Remarks: Although represented by only a few specimens, they compare in many respects with *Paralioclema mongraiensis* which was described from the Permian of Khao Ta Mong Rai, peninsular part of Thailand. However, slight differences are recognized: namely, the present form has a thinner zoarium and smaller diameter of zooecial tubes than those in the Khao Ta Mong Rai specimens.

Order Cryptostomida VINE, 1884
Suborder Rhabdomesina ASTROVA and MOROZOVA, 1956
Family Rhabdomesidae VINE, 1884
Genus ***Rhabdomeson*** YOUNG and YOUNG, 1874

Rhabdomeson consimile BASSLER, 1929

Pl. 22, fig. 6; Pl. 23, figs. 1, 2

Rhabdomeson consimile BASSLER, 1929, p. 69, pl. 237 (13), figs. 5–8; YANG, LU and XIA, 1981, p. 93, pl. 4, fig. 7; YANG and LU, 1983, p. 285, 286, pl. 3, figs. 1–3.
Rhabdomeson cf. *consimile* BASSLER, LIU, 1976, p. 152, pl. 75, fig. 7.
Rhabdomeson sp. indet., RESEARCH GROUP, 1988, pl. 19, figs. 5, 6, pl. 20, figs. 4, 6, 7.

Material and Locality: KMNH IvP 600,043a (Loc. N), 600,092b, 600,093a, 600,094b (Loc. O).

Description: Zoarium consists of cylindrical stem, diameter ranging from 0.8 to 1.0 mm. Axial region is hollow, diameter ranging from 0.17 to 0.18 mm. About 20 alternating rows of zooecial apertures transversely around the stem.

In longitudinal section, zooecial tubes arise from wall of axial tubes at angle of about 20°, are straight in endozone and curve outward rapidly at inner edge of exozone. Thickness of exozone varies from 0.20 to 0.25 mm. Superior hemiseptum not so prominent but developed at inner edge of exozone. Diaphragms lacking.

In tangential section in central part of exozone, zooecial tubes oval, longer diameter ranges from 0.19 to 0.26 mm, shorter diameter ranges from 0.13 t 0.15 mm, regularly arranged in longitudinal and diagonal directions, usually 4 zooecia per 2 mm longitudinally and probably 6 to 7 per 2 mm diagonally. Usually 1 to 2 acanthostyles at each corner of zooecial tube; they are surrounded by concentric fibers; outer and inner diameters range from 0.02 to 0.03 mm and less than 0.003 mm, respectively. Usually one row of 2 to 3 paurostyles between acanthostyles, outer diameter about 0.02 mm.

Remarks: This form well is similar in zoarial size, other microscopic measurements and other essential characters to *Rhabdomeson consimile* which was originally described from the Permian of Timor Island. This species from the Permian of Inner Mongolia (LIU, 1976) and Xizang, China (YANG, LU and XIA, 1981) is very similar to the present specimens. The species from Western Xinjiang, China (YANG and LU, 1983) seems to be slightly different from the type specimens from Timor Island in zoarial diameter and other measurements. *Rhabdomeson consimile* is not unlike *R. mammilatum* ETHERIDGE (in BRETNALL, 1926), but it differs in the smaller size of zoarial diameter.

Rhabdomeson sp. indet.

Pl. 22, fig. 4

Rhabdomeson sp. indet., RESEARCH GROUP, 1988, pl. 20, fig. 2.

Material and Locality: KMNH IvP 600,020d (Loc. K).

Remarks: From single transverse section, zoarium consists of cylindrical stem of about 1.8 mm in diameter, and has central hollow of about 0.35 mm in diameter. Thickness of exozone about 0.5 mm.

This form is similar in the general appearance to *Rhabdomeson mammilatum* ETHERIDGE (in BRETNALL, 1926) which is widely known from the Southern and Central Tethys regions. It can be distinguished from the latter species by the absence of paurostyle. Specific identification awaits better specimens.

Family Nematotrypidae SPJELDNAES, 1984

Genus *Clausotrypa* BASSLER, 1929

Clausotrypa conferta BASSLER, 1929

Pl. 23, fig. 3

Clausotrypa conferta BASSLER, 1929, p. 72, pl. 238 (14), figs. 1–3.
Clausotrypa sp. indet., RESEARCH GROUP, 1988, pl. 19, fig. 4.

Material and Locality: KMNH IvP 600,097b (Loc. O).

Description: A single oblique section shows a zoarium which may be a cylindrical stem, 2.2 mm in diameter.

In longitudinal orientation, zooecial tubes somewhat irregularly walled with one to two diaphragms. Diaphragms complete, straight or concave to surface. Diaphragms in mesozooecia abundant and regularly spaced, ranging from 0.03 to 0.04 mm intervals. Fibrous tissue surrounds acanthostyles and near surface expand.

In tangential part of the section, zooecial tubes circular with somewhat irregular margin, usually 0.13 to 0.19 mm in diameter. Mesozooecia abundant, circualr, their diameter ranging from 0.04 to 0.08 mm. Acanthostyles usually at the intersection of zooecial walls. Outer and inner diameters of acanthostyles range from 0.02 to 0.04 mm and about 0.003 mm, respectively.

Remarks: The principal characters and measurements of this form can be assigned to *Clausotrypa conferta* which BASSLER (1929) described from the Amarassi member of Timor Island. BASSLER (1929) noted that *Clausotrypa conferta* is similar to *Clausotrypa separata* in the general appearance but differs in zooecial size and their arrangements.

Clausotrypa cf. *C. thaiensis* (SAKAGAMI), 1970

Pl. 22, fig. 7

Compared:
Streblotrypa? thaiensis SAKAGAMI, 1970, p. 66, 67, pl. 13, figs. 1–4.
S.? cf. *S.*? *thaiensis* SAKAGAMI, RESEARCH GROUP, 1988, p. 20, fig. 1.

Material and Locality: KMNH IvP 600,019b (Loc. K).
Descriptive remarks: A single transverse section of cylindrical zoarium encrusted by *Fistulipora timorensis* has diameter of about 1.8 mm. Zooecial tubes arise from central axis, trend parallel to longitudinal direction and curve gradually outward in outer part of endozone. Diameter of zooecial tube ranges from 0.10 to 0.13 mm. Usually three diaphragms in zooecial tube located near aperture.

Although the present form is similar to *Clausotrypa thaiensis* which was assigned questionably to the genus *Streblotrypa* by SAKAGAMI (1970), detailed comparison cannot be made at present because only one transverse section is at hand. This form can be distinguished from the preceding described species, *C. conferta*, by the smaller zoarium and smaller zooecial tube.

Family Uncertain

Genus: ***Rhombocladia*** ROGERS, 1900

Type species: *Rhombocladia delicata* ROGERS, 1900.
Geological range: Lower Carboniferous (Visean) to Permian (Artinskian) to Guadalupian.
Remarks: When ROGERS (1900) established this genus *Rhombocladia*, he noted that the systematic position of this genus is somewhat in doubt and provisionally referred it to the Acanthocladiidae. MOORE (1929) restudied the internal structure of the type species of the genus, *Rhombocladia delicata*, and he concluded that *Rhombocladia* belongs in the Family Rhabdomesontidae. CROCKFORD (1944b) described two species of *Rhombocladia* and she put them in the Rhabdomesontidae. BASSLER (1953) also put this genus in this same family. ROSS and ROSS (1990, in Fig. 2) placed *Rhombocladia* in the Family Phylloporinidae, in association with the genera *Kallodictyon*, *Bashkirella*, *Chainodictyon* and *Pseudohornera*, but ENGEL and ROSS (1993) treated it as "Uncertain placed". *Rhombocladia* has been reported only from Permian on the Russian Platform in the Sakmarian (NIKIFOROVA, 1934, only listed species) as *Rhombocladia donaica* (sp. nov.), and Western Australia in the Artinskian (CROCKFORD, 1944b) as *Rhombocladia minor* and *Rhombocladia spinulifera*. Accordingly, *Rhombocladia nakornsri* n. sp. described here is the third species of the genus and occurs in the Southern Tethys and may by Artinskian to Guadalupian in age.

Rhombocladia nakornsri n. sp.

Pl. 23, figs. 4–8

Rhombocladia sp. nov., RESEARCH GROUP, 1988, pl. 13, figs. 1, 3, 4.

Material and Locality: KMNH IvP 600,018c, d, e, 600,019c, d, 600,020e, f, 600,021c (holotype), 600,021d, 600,022c, 600,023d, 600,024c, 600,025c, 600,026b (Loc. K); 600,050c, 600,052b (Loc. N).

Description: Zoarium nearly straight, compressed stem, 2.2 to 2.6 mm wide and 1.0 to 1.1 mm thick, and zooecia on one side only. Stems may divide dichotomously but lateral branches unknown.

In longitudinal section, zooecial tubes arise from basal lamina at an angle of about 30°, curved gradually upward, are long in endozone, make rapid right angle turn at inner edge of exozone. Thickness of exozone about 0.50 mm. Diaphragm and hemiseptum may be absent. Zooecial wall relatively thick with distinct autozooecial boundary in endozone, thickening and composed of finely laminate fibrous tissue in exozone.

In tangential section, zooecial tubes in exozone elliptical, regularly arranged in longitudinal and diagonal directions, usually 5 zooecia per 2 mm longitudinally and 6 to 6.5 per 2 mm diagonally. Longer diameter of zooecium ranges from 0.24 to 0.32 mm and shorter diameter from 0.13 to 0.15 mm. In endozone, zooecial tubes elongate and quadrate, the shorter diameter from 0.05 to 0.06 mm; becoming elongate hexagonally; arranged in slightly alternating longitudinal series. Mesozooecia absent. One acanthostyle per zoecium surrounded by concentric dark fibers, outer and inner diameters are about 0.06 mm and 0.003 mm, respectively. Paurostyles well developed, consistent in size, about 0.02 mm outer diameter, but without any particular order. Some paurostyles are prominent toward inside of zooecial tube.

In transverse section, zoarial form is seen more distinctly, namely, both obverse and reverse sides of zoarium are convex. 15 rows of zooecial apertures on upper surface.

Remarks: Not many species of *Rhombocladia* are known from the Carboniferous and Permian, and only two species: *R. minor* and *R. spinulifera* have been described by CROCKFORD (1944b) from the Callytharra and Nooncanbah Series of Western Australia. *Rhombocladia nakornsri* n. sp. can be readily distinguished from those two species by its reticulate zoarial form. This form resembles in zoarial form and general appearance *Rhombocladia ninae* which SHULGA-NESTERENKO (1955) described from the Gzhelian (C_3^{gi}) of the Upper Carboniferous in Russian Platform. It differs in colony and zooecial measurements.

The specific name is dedicated to Mr. Nikorn NAKORNSRI to commemorate his retirement from the Department of Mineral Resources, Ministry of National Development at Bangkok, Thailand.

Order Fenestrata ELIAS and CONDRA, 1957
Family Fenestellidae KING, 1849
Genus "*Fenestella*" (s. l.)

"*Fenestella*" spp. indet.

Material and Locality: KMNH IvP 600,026 (Loc. K); 600,040a, 600,047a, 600,058a (Loc. N), 600,065b, 600,069a, 600,074a, 600,083b, 600,086a, 600,089a, 600,090b, 600,094c, 600,096c, 600,097c, 600,098b, 600,099b (Loc. O).
Remarks: Many fenestellid specimens are present in the thin sections from these localities. Detailed identifications are impossible because of poor orientation of specimens.

Genus *Minilya* CROCKFORD, 1944

Minilya rhomboidea (NIKIFOROVA), 1938
Pl. 24, fig. 1

Fenestella rhomboidea NIKIFOROVA, 1938, p. 90–92, 232, 233, pl. 13, figs. 5–7, text-figs. 59–61.
Fenestella (*Minilya*) *rhomboidea* NIKIFOROVA, SAKAGAMI, 1961, p. 33, 34, pl. 16, figs. 1, 2.
Fenestella sp. cf. *F. rhomboidea* NIKIFOROVA, RESEARCH GROUP, 1988, pl. 20, fig. 8.

Material and Locality: KMNH IvP 600,034.
Description: Zoarium consists of straight parallel branches connected by dissepiments at regular intervals. Branches bifurcate at long intervals. Branch width ranges from 0.22 to 0.32 mm; 20 to 24 per 10 mm horizontally. Fenestrules quadrate with rounded corners; length from 0.32 to 0.35 mm; 20 to 21 fenestrules per 10 mm branch length. Dissepiments narrow, usually less than 0.13 mm. Zooecial tubes arranged in distinct alternating longitudinal series, usually trigonal at middle level of branch and circular at upper level of branch, 0.08 to 0.09 mm in diameter. Distance between zooecial apertures from center to center ranges from 0.22 to 0.26 mm; 20 to 21 zooecia per 5 mm longitudinally, consistent pattern of apertures in relation to dissepiments, 2 apertures per fenestrule. Two rows of zigzag nodes prominent on well-developed broad carina. Nodes about 0.06 mm in outside diameter, and spaced at same interval as apertures, namely one node to each zooecial aperture. Total number of nodes ranges from 20 to 21 per 5 mm of branch length. Stereom covers reverse side of branch and consists of inner semitransparent layer of colonial plexus with 2 to 3 capillary canals, and outer sclerenchyma of dark fibers with fine pores and granules.
Meshwork formula: 20–24/20–21//20–21//20–21* (*20–24 branches in 10 mm of zoarial width; 20–21 fenestrules in 10 mm of zoarial length; 20–21 zooecia in 5 mm of branch length; 20–21 nodes in 5 mm of branch length).

Remarks: This taxon is characterized in having short fenestrules with 2 zooecial tubes per fenestrule, 2 rows of zigzag nodes and one node to each zooecial aperture. It is similar in the meshwork formula and measurements to *Fenestella rhomboidea* which was originally described by NIKIFOROVA (1938).

Genus *Penniretepora* d'ORBIGNY, 1849

Penniretepora spp. indet.

Pl. 24, figs. 5, 6; Pl. 25, figs. 5–7

Penniretepora spp., RESEARCH GROUP, 1988, pl. 22, figs. 3–6.

Material and Locality: KMNH IvP 600,037a, 600,061a (Loc. N); 600,075a, 600,077b, 600,080a (Loc. O).

Remarks: Several different but undetermined species were recognized, however, specific identifications can not be made because of the poor preservation. Only photographic illustrations are shown.

Family Septoporidae MOROZOVA, 1962
Genus *Septopora* PROUT, 1859

Septopora cf. *S. orientalis* BASSLER, 1929

Pl. 24, fig. 2

Compared:
Septopora orientalis BASSLER, 1929, p. 87, pl. 246 (22). figs. 1, 2.
Septopora sp. cf. *S. orientalis* BASSLER, RESEARCH GROUP, 1988, pl. 23, fig. 4.

Material and Locality: KMNH IvP 600,062a, 600,064a (Loc. O).

Description: Zoarium probably fan-shaped, straight, parallel branches connected by dissepiments at regular intervals. Branches bifurcated at long intervals. Branch width ranges from 0.58 to 0.64 mm; 5 to 6 branches per 10mm horizontally. Fenestrules usually depressed arrow-head shape with rounded corners, much wider than branches, width ranging from 1.28 to 1.92 mm, length ranging from 0.64 to 0.83 mm; usually 8 fenestrules per 10mm branch length. Dissepiments narrower than branches, width ranging from 0.45 to 0.51 mm; have zooecia. Zooecia arranged in 2 rows on each main branch, 22 to 24 per 5 mm length of branch of one range, parallelogram or elongated quadrate in outline at lower to middle levels of branch, usually 6 zooeia per fenestrule. Usually 11 to 15 zooecia in 2 rows on each dissepiment. Diameter of zooecial near surface ranges from 0.12 to 0.13 mm. Distance between zooecial apertures from center to center 0.23 to 0.26 mm longitudinally. Straight carina but obscure by nodes. Stereom covers reverse side of branch, consists of

inner semitransparent layer of colonial plexus and outer sclerenchyma of darker, coarser fibers with fine granules.

Meshwork formula: 5–6/8//22–24* (*5–6 branches in 10 mm of zoarial width; 8 fenestrules in 10 mm of zoarial length; 22–24 zooecia in 5 mm of branch length).

Remarks: This form seems nearest to *Septopora orientalis* in general appearance and measurements. However, detailed comparison with the originally described specimen from Timor Island by BASSLER (1929) is impossible because the Timor specimens are only identified by surface features.

Family Polyporidae VINE, 1883
Genus ***Polypora*** M'COY, 1844

Polypora soyanensis MOROZOVA, 1970
Pl. 24, fig. 3

Polypora soyanensis MOROZOVA, 1970, p. 211, 212, pl. 48, figs. 3, pl. 49, fig. 2; SAKAGAMI, 1980, p. 278, 279, pl. 32, fig. 6.
Polypora sp. cf. *P. orientalis* (EICHWALD), RESEARCH GROUP, 1988, pl. 21, figs. 2, 3.

Material and Locality: KMNH IvP 600,001a, 600,004a, 600,005a, 600,006a, 600,009b (Loc. A).

Description: Zoarium consists of straight, parallel branches connected by dissepiments at regular intervals. Branches bifurcate at long intervals. Branch width 0.48 to 0.64 mm; usually 12 to 14 branches per 10 mm horizontally. Fenestrules oval in outline; width ranges from 0.22 to 0.32 mm; length from 0.38 to 0.48 mm; usually 11 to 12 per 10 mm of branch length. Dissepiments broad, ranging from 0.38 to 0.48 mm in width. Zooecial tubes arranged usually 3 to 4 rows on each branch but before bifurcation 5 rows, after bifurcation 2 rows; rhomboidal at middle level of branch because of strongly alternating, intercalated zooecial tubes in longitudinal series. Zooecia circular in tangential section near surface, ranging from 0.08 to 0.09 mm in diameter. Number of zooecial apertures ranges from 17 to 21 per 5 mm length of one range, usually 3 to 4 apertures per fenestrule. Interspaces between zooecial apertures from center to center range from 0.23 to 0.28 mm longitudinally. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus with many capillary canals and outer sclerenchyma of dark, coarser fibers with fine granules.

Meshwork formula: 12–14/11–12//17–21/3–4* (*12–14 branches in 10 mm of zoarial width; 11–12 fenestrules in 10 mm of zoarial length; 17–21 zooecia in 5 mm of branch length; 3–4 number of rows of zooecia).

Remarks: This specimen was previously reported and illustrated as *Polypora* sp. cf. *P. orientalis* in RESEARCH GROUP (1988). It is identical with *Poypora soyanensis*, described from the lower Kazanian of the Russian Platform, in the meshwork formula, micro-

scopic characters and measurements but differs from *Polypora orientalis* which as 2 to 3 zooecial rows on each branch. This taxon is known also from the Abadehian (= Khachik) of the Upper Permian of the Abadeh region, Central Iran (SAKAGAMI, 1980).

Polypora cf. *P. elegantissima* STUCKENBERG, 1905

Pl. 24, fig. 4

Compared:

Polypora elegantissima STUCKENBERG, 1905, p. 30, pl. 2, figs. 3a, b, NIKIFOROVA, 1938, p. 129, 130, 224, 225, pl. 27, figs. 1, 2; pl. 28, figs. 5–7.

Polypora sp. cf. *P. elegantissima* STUCKENBERG, RESEARCH GROUP, 1988, pl. 21, fig. 5.

Material and Locality: KMNH IvP 600,081a, 600,084a, 600,086b, 600,087a (Loc. O).

Description: Zoarium consists of nearly straight branches connected by dissepiments at regular intervals. Branches bifurcate frequently. Width of branch almost as wide as that of fenestrule, ranging from 0.54 to 0.64 mm (0.74 mm just before bifurcation); usually 8 to 9 branches per 10 mm horizontally. Fenestrules elongate, oval to elliptical in outline; width ranging from 0.42 to 0.64 mm; length from 1.04 to 1.28 mm, usually 6 per 10mm of branch length. Dissepiments of moderate width, ranging from 0.42 to 0.64 mm. Zooecia usually in 4 rows on each branch, but before bifurcation 5 rows, after bifurcation 3 rows; rhomboidal at middle level of branch but zooecial tubes on both sides curved outward, and circular at upper level of branch, range from 0.08 to 0.09 mm in diameter. Number of zooecial apertures ranges from 15 to 18 per 5 mm length of one range, usually 5, occasionally 6 apertures per fenestrule. Interspaces between zooecial apertures from center to center range from 0.23 to 0.32 mm longitudinally. Stereom covering reverse side of branch, consists of semitransparent layer of colonial plexus and outer sclerenchyma of darker fibers with fine granules.

Meshwork formula: 8–9/6//15–18/4 (3–5)

Remarks: The original specimen of *Polypora elegantissima* was described by STUCKENBERG (1905) and was reexamined by NIKIFOROVA (1938). This form seems nearest to *Polypora elegantissima* in essential characters and measurements, but slight differences are recongnized from the NIKIFOROVA's description, especially in the meshwork formula: 7–9/4.5//13–14/4.

Polypora cf. *P. multiporifera* CROCKFORD, 1944

Pl. 25, figs. 1, 2

Compared:

Polypora multiporifera CROCKFORD, 1944a, p. 177, 178, pl. 3, fig. 4; CROCKFORD, 1957, p. 62 (not illustrated); SAKAGAMI, 1966, p. 160, 161, pl. 6, fig. 4 (erroneously spelled as *multiporiferata*); ENGEL and ROSS, 1993, p. 48 (microfiche), pl. 18, figs. 9, 10.

Polypora cf. *multiporifera* CROCKFORD, SUGIMURA, 1974, p. 4, 5, pl. 1, figs. 3–5; RESEARCH GROUP, 1988,

pl. 23, fig. 3.

Material and Locality: KMNH IvP 600,062b, 600,063a, 600,067a, 600,068b, 600,072b, 600,079a (Loc. O).

Description: Zoarium consists of straight, parallel, robust branches connected by dissepiments spaced usually at regular intervals. Branches bifurcate rather frequently. Branch width ranges usually from 0.70 to 0.96 mm, 5 to 6 branches per 10mm horizontally. Fenestrules elongate, oval to elliptical in outline; width ranges from 0.51 to 0.96 mm; length ranges from 2.24 to 2.88 mm, but 0.38 to 0.77 mm in rare cases; usually about 3 per 10 mm branch length. Width of branch ranges from 0.51 to 0.64 mm. Width of dissepiments varies from 0.48 to 0.64 mm. Zooecial tubes arranged in strongly alternating longitudinal series, usually rhomboidal at middle level of branch, usually 6 rows on each branch, before bifurcation 7 to 8 rows, after bifurcation 5 rows; 12 to 15 per 5 mm length of one range, usually 8 to 10 apertures per fenestrule. Zooecia circular in tangential section near surface, ranging from 0.09 to 0.10 mm in diameter. Distance between zooecial apertures from center to center ranges from 0.31 to 0.36 mm longitudinally. Thick stereom covers reverse side of branch, consists of semitransparent layer of colonial plexus with many, more than 10 capillary canals, and outer sclerenchyma of darker fibers with fine granules.

Meshwork formula: 5–6/ca. 3//12–15/6(5–8).

Remarks: This form agrees with *Polypora multiporifera*, originally described from the Wandagee Series by CROCKFORD (1944a), in the essential characters except for a slight difference in the meshwork formula, especially in the number of fenestrules per 10mm length of branch; about 3 in the present form instead of 1.5–2.5 in the holotype. *Polypora* cf. *P. multiporifera* described by SUGIMURA (1974) has slightly wider branch and greater distance between zooecial apertures than the holotype and the present specimens.

Polypora koninkiana WAAGEN and PICHL, 1885

Pl. 25, figs. 3, 4

Polypora koninckiana WAAGEN and PICHL, 1885, p. 783–785, pl. 87, fig. 5; pl. 88, fig. 4; pl. 90, fig. 1.
Polypora cf. *koninckiana* WAAGEN and PICHL, YANG, 1955, p. 107, pl. 59, fig. 7; LOO (= LU), 1958, p. 295, 296, 301, pl. 1, fig. 3.
Polypora sp. indet., RESEARCH GROUP, 1988, pl. 22, fig. 1.

Material and Locality: KMNH IvP 600,035a, 600,036a, 600,039a, 600,040b, 600,042a, 600,044a, 600,046a (Loc. N).

Description: Zoarium consists of straight parallel, robust branches, connected by dissepiments at regular intervals. Branches bifurcate frequently. Branch width 0.96 to 1.28 mm; 4 to 7 branches per 10 mm horizontally. Fenestrules elongate, oval to elliptical in outline; width ranges from 0.96 to 1.28 mm; length ranges from 1.92 to

2.24 mm; usually 4 per 10 mm length of branch. Width of dissepiment ranges from 0.51 to 0.64 mm. Zooecial tubes arranged in strongly alternating longitudinal series, usually rhomboidal at middle level of branch, 6 to 7 rows on each branch, but after bifurcation 4 rows, about 16 per 5 mm length in one range, usually 8 apertures per fenestrule. Zooecia circular in tangential section near surface, ranging from 0.10 to 0.12 mm in diameter. Distance between zooecial apertures from center to center ranges from 0.26 to 0.32 mm longitudinally. Relatively thin stereom covering reverse side consists of inner semitransparent layer of colonial plexus and outer sclerenchyma of dark, coarser fibers with many prominent spicules usually 0.005 mm, occasionally 0.01 mm, in diameter.

Meshwork formula: 4–7/4//ca. 16/6–7.

Remarks: This form is identical with *Polypora koninckiana*, originally described from the Middle to Upper divisions of the Productus limestone, in the meshwork formula and is very similar in general appearance. The present species was also described as the *confer* forms from the Chihsia Limestone of China by YANG (1955) and LOO (= LU) (1958), but the Chinese specimens are slightly different in the number of fenestrules in 10mm branch length, -i.c. about 5.5 in contrast to 4 to 5 in the present form.

***Polypora* spp. indet.**

Material and Locality: KMNH IvP 600,023e, 600,026c (Loc. K); 600,095b, 600,099c, 600,100b, 600,101b, 600,102b (Loc. O).

Remarks: Some specimens belonging to the genus *Polypora* are found in the thin sections from the above mentioned localities, but they are poorly preserved and indeterminable.

Acknowledgments

This study is dedicated to Mr. Nikorn NAKORNSRI to commemorate his retirement from the Department of Mineral Resources, Ministry of National Development at Bangkok (Thailand). Since starting my geological and paleontological studies in Thailand in 1965, I have visited Thailand many times, and Mr. NAKORNSRI always willingly guided us to the field sites. Here, I would like to express my sincere thanks to him for his kind cooperation and warmest friendship, and sincerely hope that he will enjoy long retirement.

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Permian Bryozoans from some localities in the Khao Hin Kling area near Petchabun, North-central Thailand

Sumio SAKAGAMI

Plates 18–25

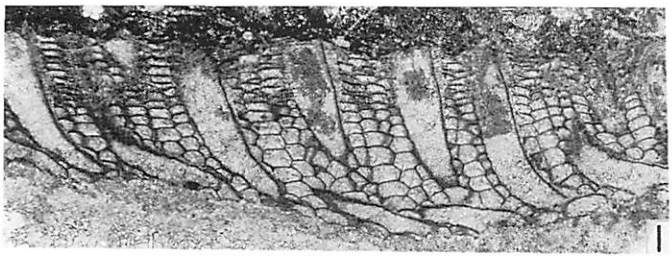
Explanation of Plate 18

Figs. 1–3. *Fistulipora timorensis* BASSLER

1. Longitudinal section, zoarium attached on a sponge colony (*Amblysiphonella*?), × 20, KMNH IvP 600,030a.
2. Longitudinal section, zoarium attached on *Paralioclema mongraiensis*, × 20, KMNH IvP 600,020a.
3. Tangential section, × 20, KMNH IvP 600,020b.

Figs. 4–6. *Fistulipora siamensis* n. sp.

4. Longitudinal section of holotype, × 20, KMNH IvP 600,098a.
5. Tangential section of paratype, × 20, KMNH IvP 600,095a.
6. Enlarged part of Fig. 5, × 40.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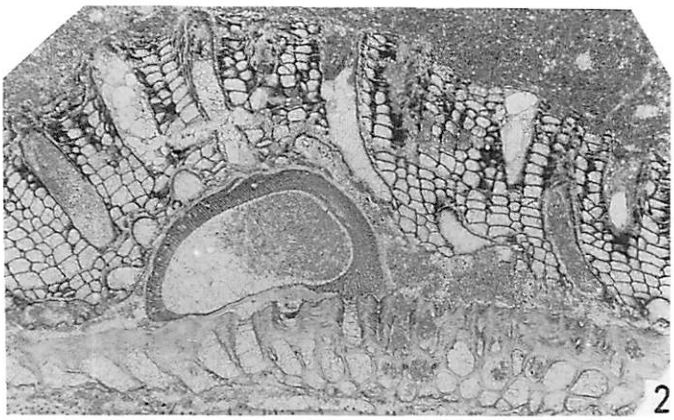
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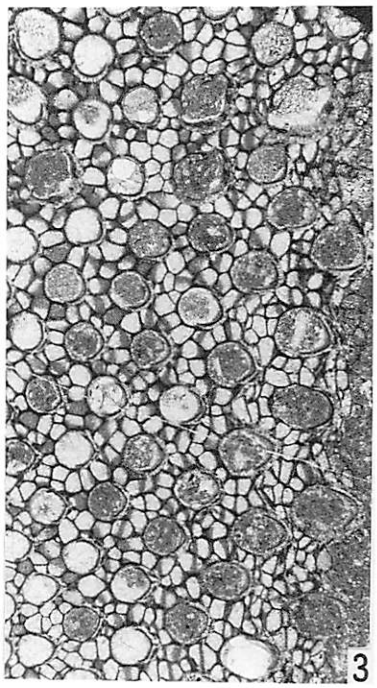
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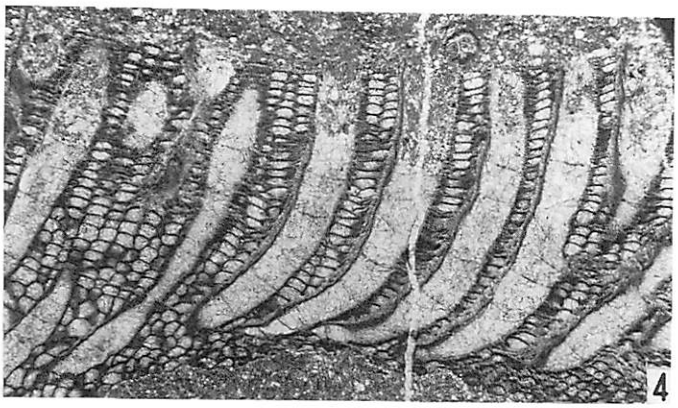
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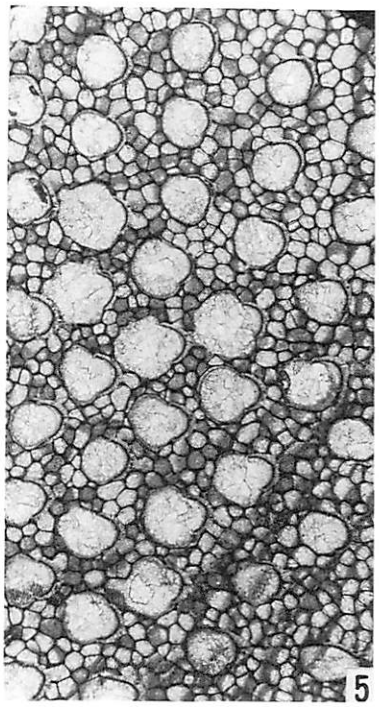
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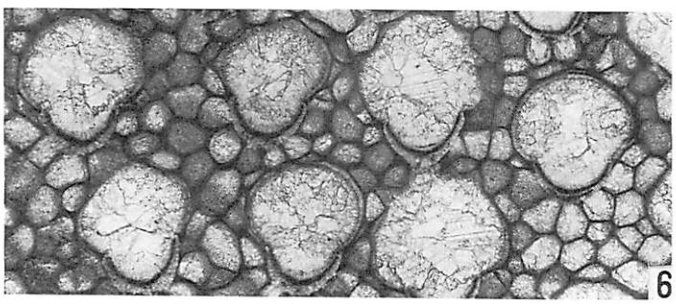

6

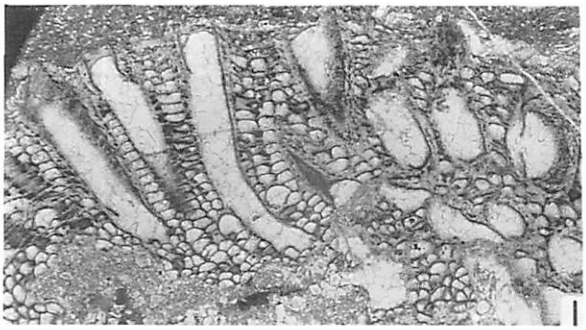
Explanation of Plate 19

Figs. 1–3. *Fistulipora sawatai* n. sp.

1. Longitudinal section of holotype, × 20, KMNH IvP 600,091a.
2. Tangential section, a part of holotype, × 20.
3. Enlarged part of Fig. 2, × 40.

Figs. 4–6. *Eridopora parasitica* (WAAGEN and WENTZEL)

4. Longitudinal section, zoarium attached on *Rhombocladia nakornsri*, × 20, KMNH Ivp 600,021a.
5, 6. Tangential sections, × 20, KMNH IvP 600,021b and 600,018b, respectively.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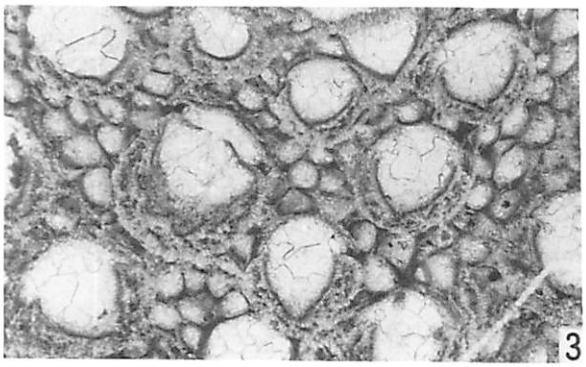
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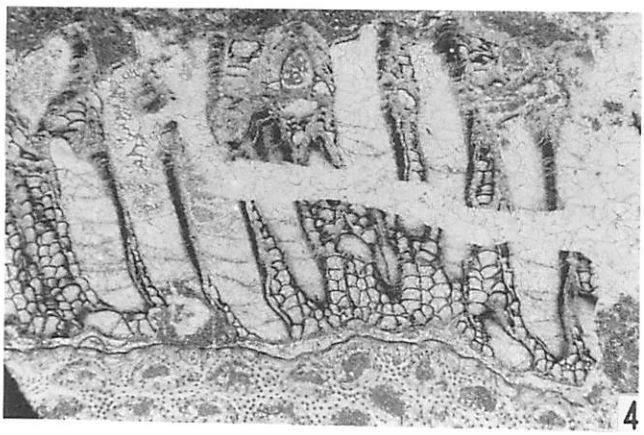
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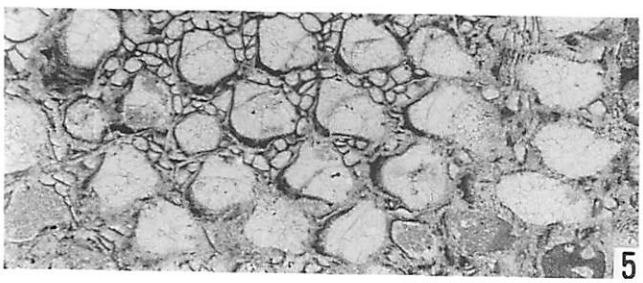
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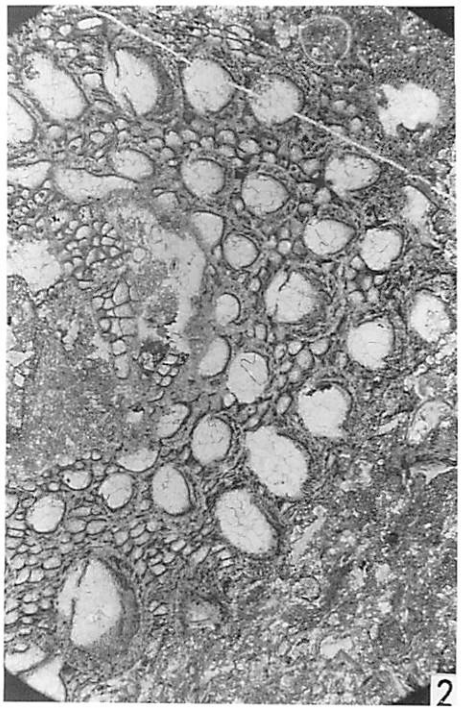
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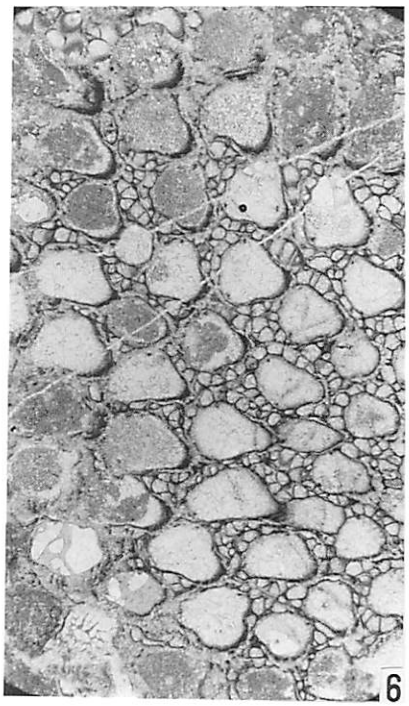

6

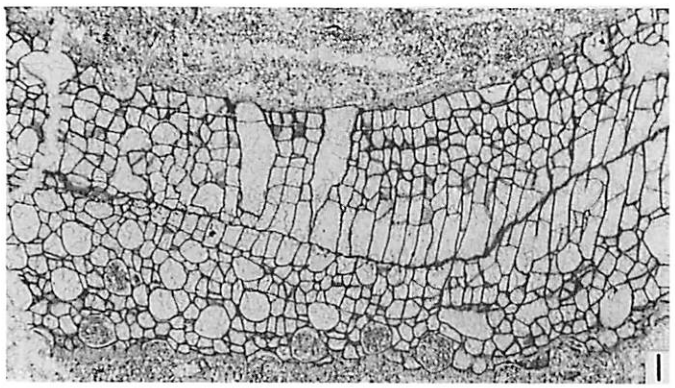
Explanation of Plate 20

Figs. 1–4. *Hexagonella tortuosa* WAAGEM and WENTZEL

1. Oblique longitudinal section, × 20, KMNH IvP 600,077a.
2, 4. Typical tangential sections near surface, showing well developed hexagonellid ridges, × 20, KMNH IvP 600,096b and 600,054b, respectively.
3. Tangential section of endozone, × 20, KMNH IvP 600,076a.

Figs. 5, 6. *Fistulocladia*? sp. indet.

5. Transverse section, × 20, KMNH IvP 600,086a.
6. Oblique transverse section, × 20, KMNH IvP 600,085a.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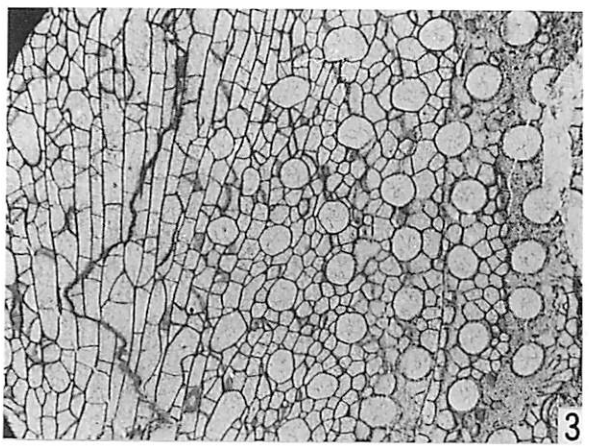
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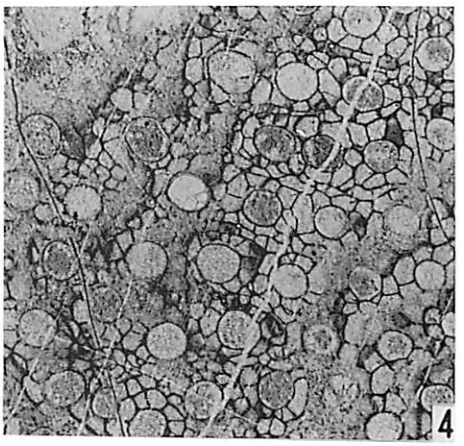
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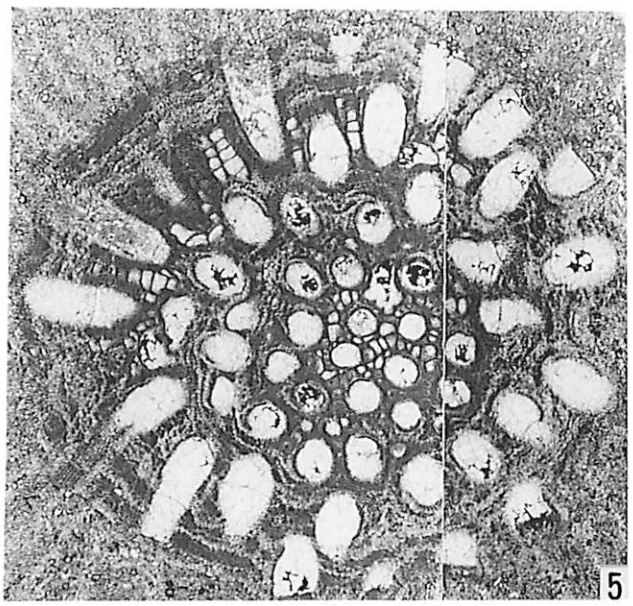
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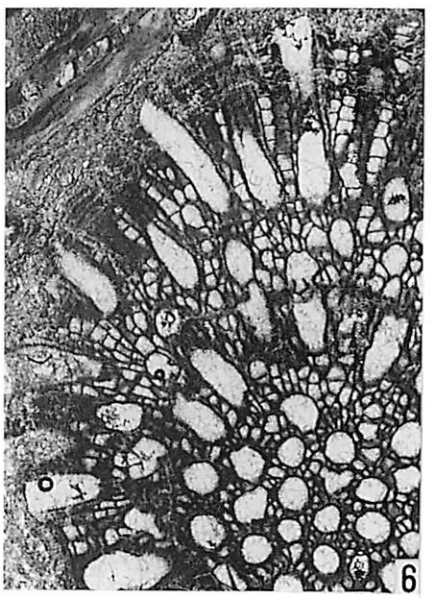
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Explanation of Plate 21

Figs. 1–3. *Liguloclema meridianus* (ETHERIDGE)

1. Oblique tangential section in endozone, showing the branched part, × 20, KMNH IvP 600,083a.
2, 3. Parts of longitudinal and tangential sections in the same zoarium, × 20.

Fig. 4. *Sulcoretepora*? sp. indet.

Transverse sections, × 20, KMNH IvP 600,025b.

Fig. 5. *Pseudobatostomella* sp. indet.

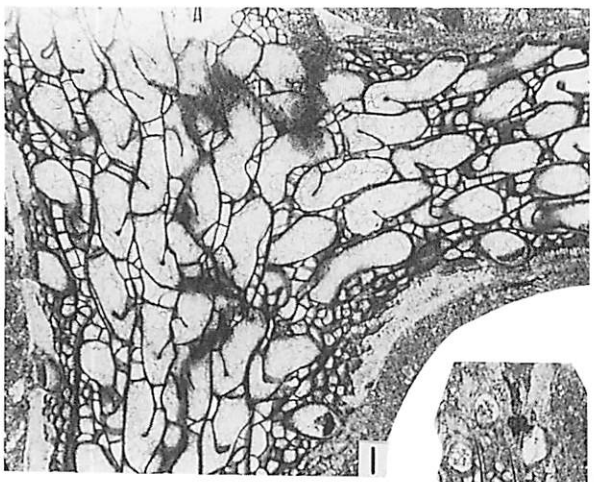
Oblique section, × 20, KMNH IvP 600,023a.

Fig. 6. *Rhombotrypella* sp. indet.

Oblique longitudinal section, × 20, KMNH IvP 600,051c.

Fig. 7. *Pseudobatostomella multidiaphragma* SAKAGAMI

Oblique longitudinal section, × 20, KMNH IvP 600,015a.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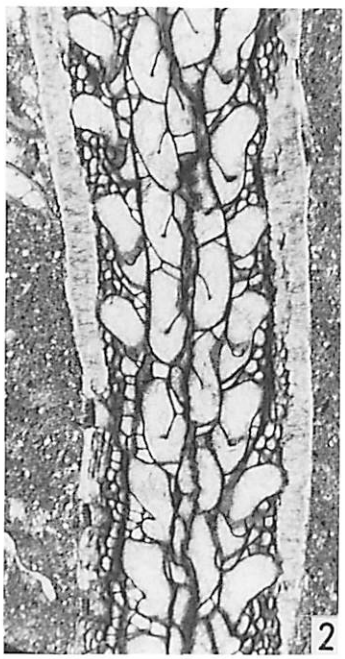
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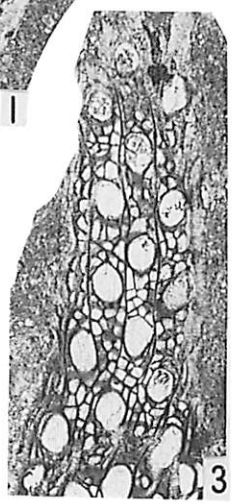
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Explanation of Plate 22

Fig. 1. *Pseudobatostomella multidiaphragma* SAKAGAMI

Oblique tangential section, × 20, KMNH IvP 600,017a.

Figs. 2, 3. *Paralioclema* cf. *P. mongraiensis* (SAKAGAMI)

2. Longitudinal section, attached on *Rhombocladia nakornsri* and covered by *Fistulipora timorensis*, × 20, KMNH IvP 600,020c (see also Pl. 1, fig. 2).
3. Oblique tangential section, × 20, KMNH IvP 600,022b.

Fig. 4. *Rhabdomeson* sp. indet.

Oblique transverse section, × 20, KMNH IvP 600,020d.

Fig. 5. *Araxopora araxensis* (NIKIFOROVA)

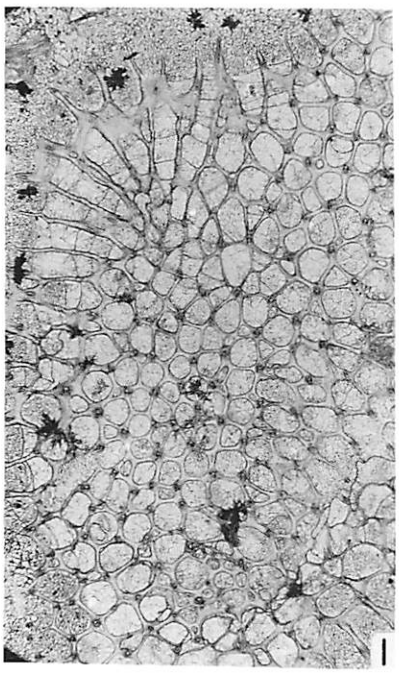
Transverse section (the endozone is obliterated), × 20, KMNH IvP 600,031a.

Fig. 6. *Rhabdomeson consimile* BASSLER

Oblique longitudinal section, × 20, KMNH IvP 600,043a.

Fig. 7. *Clausotrypa* cf. *C. thaiensis* (SAKAGAMI)

Typical transverse section, covered by *Fistulipora timorensis*, × 20, KMNH IvP 600,019b.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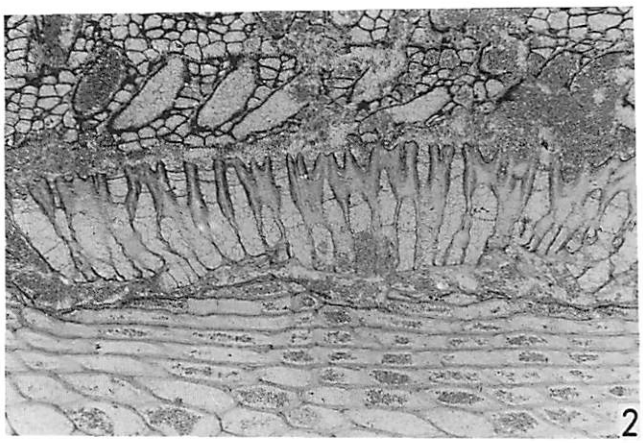
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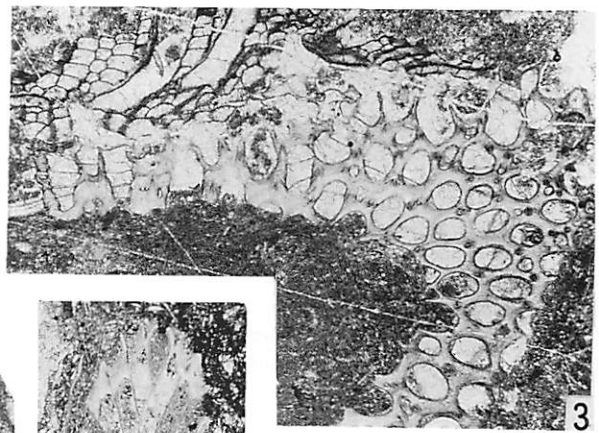
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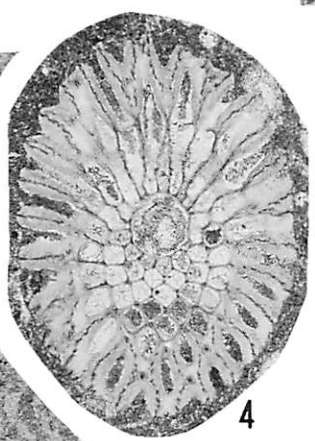
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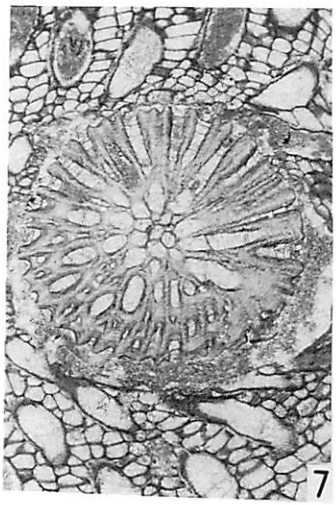
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Explanation of Plate 23

Figs. 1, 2. *Rhabdomeson consimile* BASSLER

1. Typical longitudinal (but tangential in part) section, × 20, KMNH IvP 600,094b.
2. Typical transverse section, × 20, KMNH IvP 600,093a.

Fig. 3. *Clausotrypa conferta* BASSLER

Oblique section, × 20, KMNH IvP 600,097b.

Figs. 4–8. *Rhombocladia nakornsri* n. sp.

4. Transverse section of paratype, × 20, KMNH IvP 600,018c.
5. Tangential section of paratype, × 20, KMNH IvP 600,020d.
6. Tangential section of holotype, × 20, KMNH IvP 600,021c.
7. Enlarged part of Fig. 6, × 40,
8. Longitudinal section of paratype, covered by *Fistulipora timorensis*, × 20, KMNH IvP 600,018d.


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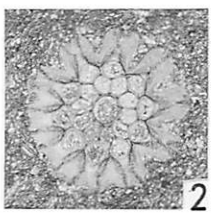
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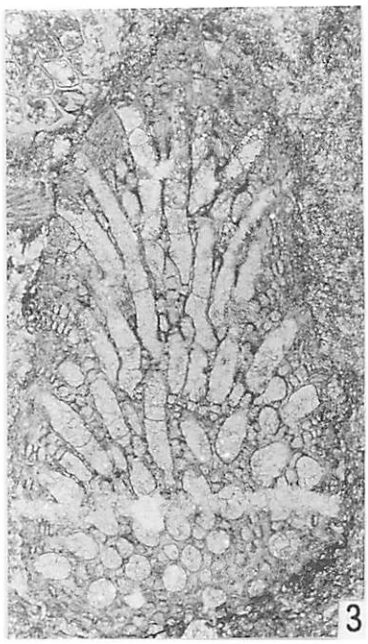
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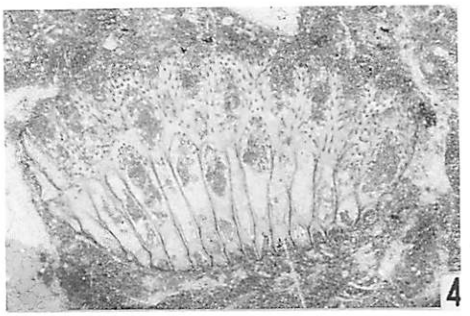
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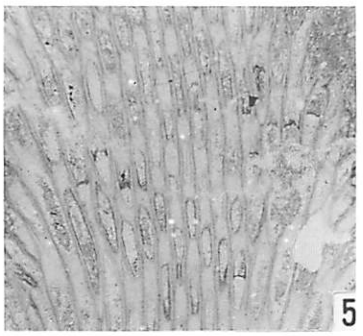
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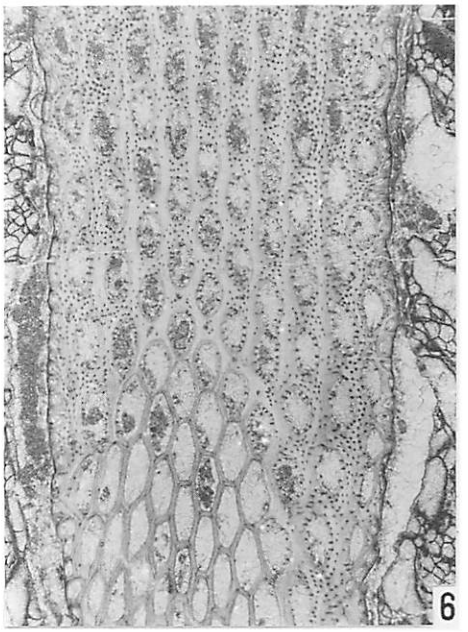
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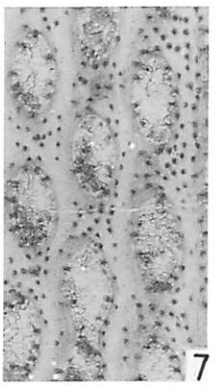
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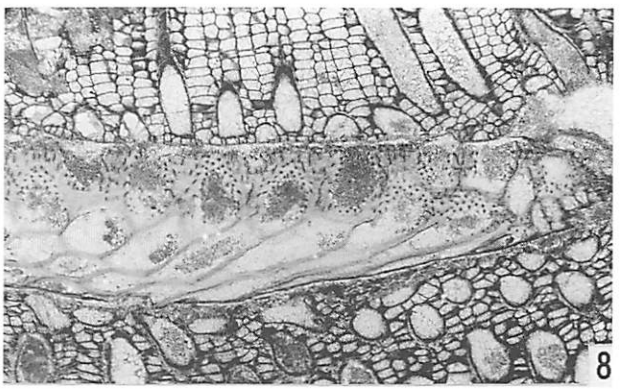
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Explanation of Plate 24

Fig. 1. *Minilya rhomboidea* (NIKIFOROVA)

Tangential section, × 20, KMNH IvP 600.034a.

Fig. 2. *Septopora* cf. *S. orientalis* BASSLER

Tangential section, × 20, KMNH IvP 600,062a.

Fig. 3. *Polypora soyanensis* MOROZOVA

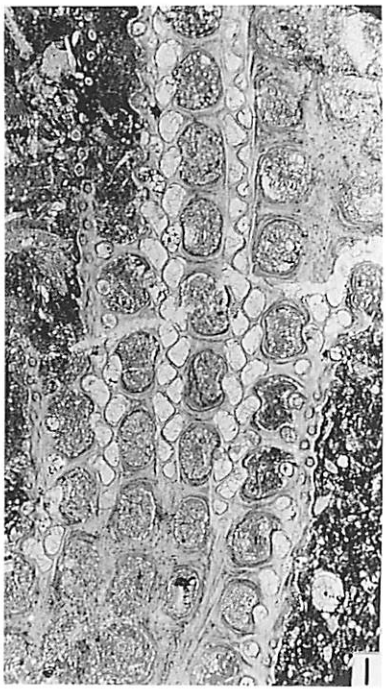
Tangential section, × 20, KMNH IvP 600,005a.

Fig. 4. *Polypora* cf. *P. elegantissima* STUCKENBERG

Tangential section, × 20, KMNH IvP 600.081a.

Figs. 5, 6. *Penniretepora* spp. indet.

Tangential sections, × 20, KMNH IvP 600,080a and 600,077b, respectively.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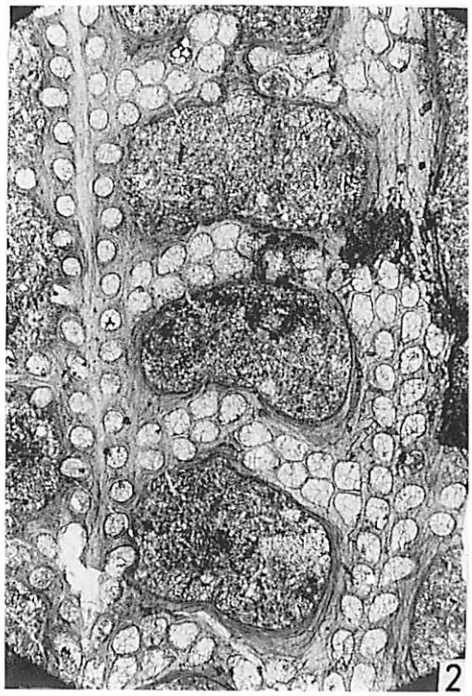
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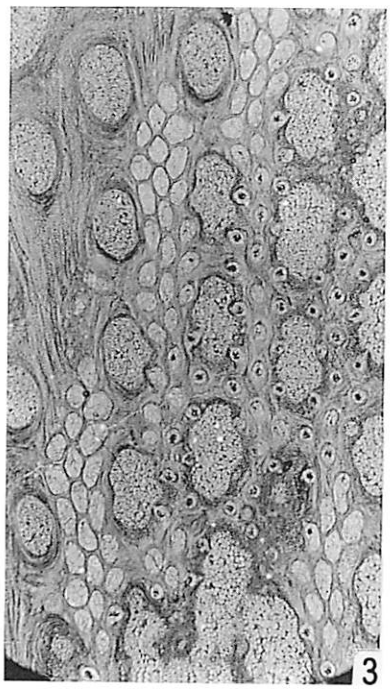
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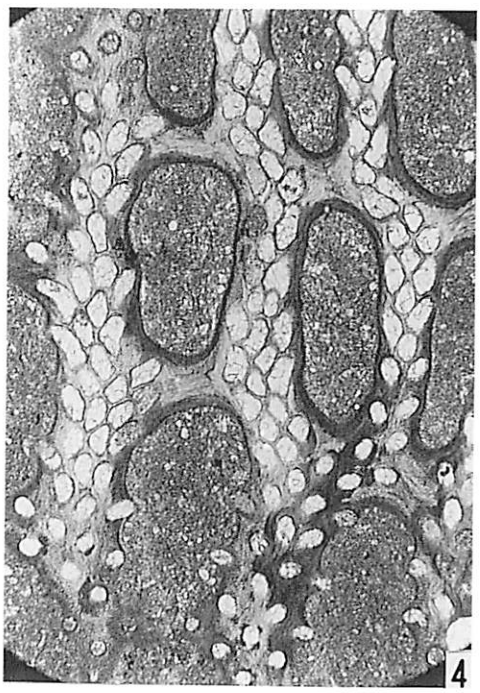
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Explanation of Plate 25

Figs. 1, 2. *Polypora* cf. *P. multiporifera* CROCKFORD
Tangential sections, × 20, KMNH IvP 600,067a and 600,072b, respectively.

Figs. 3, 4. *Polypora koninckiana* WAAGEN and PICHL
3. Tangential section, × 20, KMNH IvP 600,046a.
4. Transverse section, × 20, KMNH IvP 600,040a.

Figs. 5–7. *Penniretepora* spp. indet.
Tangential sections, × 20, KMNH IvP 600,075a, 600,037a and 600,061a, respectively.


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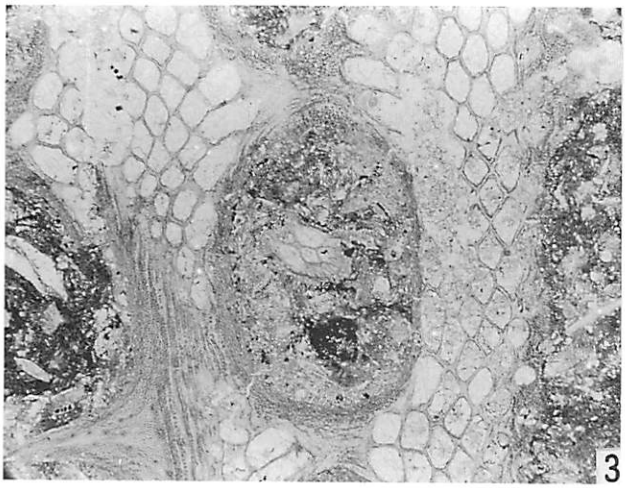
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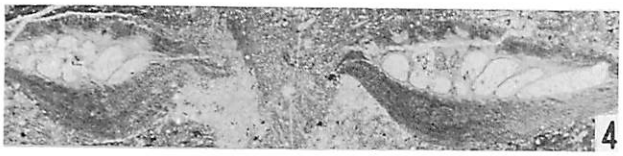
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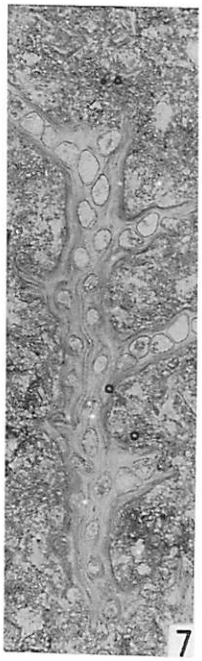
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